Session: C12 Poster: M48B

How does vertical velocity affect marine stratiform cloud cover?

Timothy Myers[†]; Joel Norris
[†] Scripps Institution of Oceanography, USA
Leading author: tamyers@ucsd.edu

We investigate artifact-corrected International Satellite Cloud Climatology Project (ISCCP) low-level cloud fraction over five major stratus and stratocumulus regimes over the subtropical oceans and its relationship to vertical velocity from reanalysis data over the seasonal cycle. While estimated inversion strength (EIS) explains most the variability of cloud cover in these regimes (hereafter referred to as Marine Stratiform Cloudiness (MSC)), substantial variability remains unexplained. We find that vertical velocity above the Marine Boundary Layer (MBL) is highly correlated and in phase with MSC, such that stronger subsidence seemingly favors more MSC, consistent with the hypothesis that stronger subsidence leads to a shallower MBL and thus more MSC. However, stronger subsidence also enhances adiabatic warming above the MBL, favoring higher EIS, suggesting that the subsidence-MSC relationship is coincidental. To investigate the independent role of subsidence in forcing MSC, we perform a multi-linear least-squares regression, using EIS and vertical velocity as the predictors and MSC as the predictand. Based on this analysis, we find that, when EIS is fixed, stronger subsidence actually favors less MSC. To further investigate the role of subsidence, we filter out from vertical velocity its relationship to EIS via linear least-squares regression. We find that, when EIS is constrained to its middle values, stronger subsidence favors less MSC, consistent with the multi-linear regression results. For each method, the independent subsidence-MSC relationship is found to be statistically significant. The results challenge the canonical understanding of the role of subsidence in forcing MSC and underscore the need for careful analysis when interpreting highly correlated climate variables. The results also are highly relevant to projections of MSC under greenhouse forcing, which predict that over the eastern subtropical oceans, EIS will increase while subsidence will decrease. The sign of the independent subsidence-MSC relationship determined in this study is thus important, and implies that MSC may increase as subsidence weakens under greenhouse forcing, thereby partially offsetting warming since MSC has a cooling effect on the climate.